DESIGN OF A WATER SUPPLY SYSTEM

FOR

PARK RIDGE, ILLINOIS

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THE DESIGN OF A WATER SUPPLY SYSTEM FOR PARK RIDGE, ILL.

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PRESENTED BY

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Foreword.

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INTRODUCTION.

The City of Park Ridge, Cook County, Illinois, is situated on the Wisconsin Division of the Chicago and Northwestern Railway and is thirteen miles northwest of the Chicago and Northwestern Railway Terminal. The eastern city limits of Park Ridge is the western city limits of the City of Chicago. Park Ridge was incorporated as a city under the State Laws of Illinois in the year 1910.

Owing to the fact that the City is just outside of Chicago, its population has increased considerably in the last few years, and in all probability will continue at even a greater rate during the next twenty to twenty-five years, as the City is only residential. The present population, according to the latest school census, was about three thousand five hundred, composed largely of Chicago business men.

The municipality has a water system which

partially satisfies its present demands, and consists of two deep well plunger pumps, pumping from deep artesian wells into a Chicago Bridge and Iron Works Standard 100,000 gal. elevated tank against a head of 100 feet; 8900 feet of six inch cast iron water mains and 60,120 feet of four inch cast iron water mains with a limited number of fire hydrants and gate valves.

It is the purpose of this thesis to design an economical water system for future growth; this design to utilize the present mains as far as possible. In the design, the population will be allowed for in an approved population per acre method, and an average per capita water consumption will be assumed. The amount of consumption will be seperated into three periods. 1st. the present consumption, 2nd. an assumed consumption for the end of ten years, 3rd. a maximum consumption for the future growth of the City.

DESIGN OF WATER SUPPLY SYSTEM
FOR PARK RIDGE, ILLINOIS.

The Work Proposed is to Contain:

I. Map of the Present and Proposed Water Mains.

II. Determination of Water System.

1. Distribution of Population.
2. Distribution for Pressure Main.
3. Design of the Distributing System.
4. Location of Hydrants and Gate Valves.

III. Investigation of the Present Supply.

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1. For 10 year Growth.
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1. Present Demand.
2. Ten Year Demand.
3. Full Growth to the Extended City Limits.

II. DETERMINATION OF WATER SYSTEM.

1. Distribution of Population:- A quarter section of residence district will usually be divided into eight blocks of five acres each. Each block will ordinarily be subdivided into twenty-four fifty foot lots. An average population distribution for a residence district of this type may be based on a plan of five people to each fifty foot lot. Under this assumption an average value of twenty five people to the acre will be used.

The daily per capita water consumption in a purely resident district is taken as one hundred and ten gallons. It is assumed that this one hundred and ten gallons per capita will be required during only ten of the twenty four hours. Under these assumptions, the required pipe capacities may be calculated. This value gives a quantity of 2750 gallons per acre per ten hour day for all built up sections and as the system is a gravity system with

an average head of 100 feet at the pumping station, the minimum pressure head to be allowed at any fire hydrant is assumed to be 60 feet.

2. Distribution for Pressure Main:- The map showing the present water system was worked up before any definite designing was undertaken. The distribution of the pressure was next assumed by referring to the above map and selecting the system that would most likely give the highest terminal pressures. When this system had been worked out, the areas supplied by each pressure main was measured and the required discharge calculated.

The areas enclosed within the assumed extended city limits of the City has been divided into five sections. The water required for each part will be supplied by a pressure main leaving the central pumping station and carrying water to each section of the city. Section

one will include the area lying within the following boundary: Beginning at the intersection of Western Avenue extended and Sibley Avenue extended, thence east on Sibley Avenue extended to Greenwood Avenue extended, thence south in Greenwood Avenue extended, to the intersection of Park Avenue, thence southeast in Park Avenue to the intersection of Center St., thence west in Center St. to the intersection of Cumberland Ave., thence south in Cumberland Ave. and Cumberland Ave. extended to the south city limits, thence west on the south city limits extended to the intersection of Western Ave. extended, thence north in Western Ave. extended, Western Avenue and Western Avenue extended to the point of beginning.

Section two will include the area lying within the following boundary: Beginning at the same point of beginning as described above for section one, namely, the intersection of Western Avenue extended and Sibley Avenue ex-

tended, thence north on Western Avenue extended to the north city limits extended, thence east on the north city limits to the intersection of Washington Street extended, thence south on Washington Street extended and Washington Street to the intersection of Washington and Center Streets, thence west on Center Street to the intersection of Park Avenue, thence northwest in Park Avenue to the intersection of Park Avenue and Greenwood Avenue extended, thence north in Greenwood Avenue extended to the intersection of Sibley Avenue extended, thence west in Sibley Avenue extended to the point of beginning.

Section three will include the area lying within the following boundary: Beginning at the intersection of Washington Street extended and the north city limits, then east on the north city limits to the intersection of the east city limits, thence south on the east city limits to the intersection of Park Ave.

thence northwest on Park Avenue to the intersection of Center Street, thence east on Center Street to the intersection of Washington Street, thence north on Washington Street and Washington Street extended to the point of beginning.

Section four will include the area lying within the following boundary:- Beginning at the intersection of Prospect Avenue and Center Street, thence west in Center Street to the intersection of Cumberland Avenue, thence south in Cumberland Ave. and Cumberland Ave. extended to the intersection of the south city limits, thence east on the south city limits to the intersection of Crescent Avenue extended, thence north in Crescent Avenue extended to the intersection of Belle Olaine Avenue, thence east in Belle Plaine Ave. to the intersection of South Washington Avenue, thence north in South Washington Ave. to the intersection with the C. & N.W. R.R., thence north

west along the center line of the C.&N.W. railroad, to the intersection of Prospect Avenue, thence north in Prospect Avenue to the point of beginning.

Section five will include the area lying within the following boundary: Beginning at the intersection of Park Avenue and Prospect Avenue, thence southeast in Park Avenue to the east city limits, thence south along the east city limits to the intersection of the south city limits, thence west along the south city limits to the intersection of Crescent Avenue extended, thence north in Crescent Avenue extended to the intersection of Belle Plaine Avenue, thence east in Belle Plaine Ave. to the intersection of South Washington Avenue, thence north on South Washington Ave. to the intersection with the C.&N.W.R.R., thence northwest along the center line of the C.&N.W. R.R. to the intersection of Prospect Avenue, thence northeast in Prospect Avenue to the

point of beginning.

Section one, containing 475 acres which require 1,300,000 gallons per ten hour day, will be supplied by a new 16" pressure main and is to be combined with the old 6" main now laid in Center St. The 16" main will start at the pumping station and extend west in Center St., to the intersection of South Clifton Ave. and Center St. Beginning at the intersection of South Clifton Avenue andCenter St. a 12" pressure main will extend to the intersection of Greenwood Ave. and Center St. This main will supply the part of Section one lying west of Cumberland Ave. which contains 425 acres requiring 1,170,000 gallons per ten hour day. One-eighth mile of 10" and one-eighth mile of 8" pipe will extend from Greenwood Ave. to Western Ave. A 6" pressure main will leave the above described main at Center Street and Clifton Ave. and extend south in Clifton Ave. to the intersection of the 4" main now laid

in Clifton Ave. This main will serve as a pressure booster for the 4" main now laid in that district. Beginning at Greenwood Avenue and west to Western Ave., sub-mains will extend from Center St. pressure main south to intersect a 6" main to be put in Chicago Road to extend from the intersection of Chicago Road and south city limits to the intersection of Chicago Road and Western Avenue extended. Each of these sub-mains with the exception of the main provided in Greenwood Ave., will supply the strip of area one block wide and extending from Center Street to Chicago Road. The main in Green wood Avenue will supply in addition to this strip the area included within the following boundary; Beginning at the intersection of Greenwood and Belle Plaine Avenues, thence east on Belle Plaine Ave. to the intersection of Cumberland Ave., thence south on Cumberland Ave. extended to the intersection of Chicago Road, thence northwest

in Chicago Road to the intersection of Greenwood Ave. extended, thence north in Greenwood Avenue extended to the point of beginning. All of these sub-mains will be 6" mains with the exception of the Greenwood Avenue main, which will be an 8" main. Four inch lateral mains are to be fed by this system of pressure to give the required quantity of water to each lot and the required pressure at all fire hydrants.

Section two, containing 480 acres, requiring 1,320, 000 gallons per ten hour day, will be supplied by a new 16" main to lie in North Prospect Avenue, extending from the pumping station north to the intersection of Sibley Ave. this main to be combined with the old 6" main now laid in North Prospect Avenue. Beginning at this point a 12" main is required and will extend to a point 1550 feet north of Sibley Avenue, and a 6" main will be laid in Prospect Avenue to extend from this point to

the north city limits and to connect with a 6" main to be laid the full length of the north city limits.

That part of Section two lying north of Sibley Avenue and west of Prospect Avenue is divided into two sub-divisions. Sub-divisions one contains the area lying between Sibley Ave. on the south and a line parallel to Sibley Ave. and 1550 feet north of Sibley Avenue on the north, and between Prospect Ave. on the east and Western Avenue extended on the west, This area, containing 159 acres, and requiring 415,500 gallons per ten hour day, will be supplied by a new 8" main in Sibley Avenue and to extend from the intersection of Prospect Avenue and Sibley Avenue to the intersection of Greenwood Avenue extended and Sibley Ave. This main to be combined with the old 6" main now in Sibley Avenue, extending from Prospect Avenue to Meacham Avenue. A 6" main is to be laid in Sibley Avenue to extend from Greenwood

Avenue extended to the intersection of Western Avenue extended, and is to connect with a 6" main to be laid the full length of Western Avenue extended and Western Avenue. Sub-division two, contains the area lying between the line parallel to Sibley Avenue and 1550 feet north of Sibley Avenue and the north city limits and between Prospect Avenue and Western Avenue extended. This area, containing 100 acres, and requiring 275,000 gallons per ten hour day, will be supplied by a main similar to the main proposed for Sibley Ave. This main to be laid along the line parallel to Sibley Avenue and lying 1550 feet north of Sibley Avenue. A system of 4" lateral mains will be fed from this system of pressure mains to give the required quantity of water to each lot and to give the required pressure for fire hydrants.

Section three, containing 200 acres, and requiring 550,000 gallons per ten hour day,

will be supplied by a 10" main in Center Street, extending from the pumping station east to a point 660 feet east of Washington Street. A 6" main will extend in Center St. from this point to the intersection of the east city limits and it will connect with a 6" main to be laid along the full length of the east city limits. From the point in Center St. 660 feet east of Washington Street, a 10" pressure main will extend north to a line parallel to Washington Street to the intersection of Elm Street extended. The part of Section three north of Elm Street, containing 120 acres, and requiring 330,000 gallons per ten hour day, will be supplied by an 8" pressure main to be laid on a line parallel to Washington St. and 660 feet east of Washington Street from the intersection of this line with Elm Street extended to the intersection of this line and Sibley Avenue extended. A 6" main will be laid along this same line ex-

tending from Sibley Avenue extended to the intersection of this line with the north city limits and will connect with a 6" main to be laid along the north city limits. A 6" main will be laid along a line 660 feet east and parallel to Washington Avenue, extending from the intersection of this line and Center St. to the intersection of the above line and Park Avenue. A system of 4" lateral mains are to be fed by this system of pressure mains to give the required quantity of water to each lot; and required pressure for fire hydrants.

Section four, containing 240 acres, and requiring 660,000 gallons of water per ten hour day, will be supplied by a new 8" main beginning at the pumping station and extending southwest in Prospect Ave. to the intersection of Prospect Ave. and Courtland Ave. This main will be combined with the old 6" main now in south Prospect Ave. Beginning at the intersection of south Prospect Ave. and Courtland Ave.

a 10" main will be laid in Courtland Ave. extending from Prospect Ave. to Belle Plaine Ave. and an 8" main will be laid from Belle Plaine Ave to 4th Ave., and a 6" main from 4th Ave. to the south city limits. This main will connect to a 6" main to be laid in the south city limits extending from the intersection of the south city limits to Chicago Road east to the intersection of the east city limits. a 6" pressure main will be laid in 2nd. Ave. extended from Courtland Ave.to the intersection of Cumberland Ave. extended, and it will connect at this point with a 6" main to be laid in Cumberland Ave. extended, from Belle Plaine Ave. to the intersection of 3rd. Ave. extended. A system of 4" lateral mains will be fed by this system of pressure mains to give the required quantity of water to each lot, and the required pressure at fire hydrants.

Section five, containing 220 acres, and requiring 606,000 gallons of water per ten

hour day, will be supplied by a 10" pressure main in east Park Ave. beginning at the pumping station and extending southeast to the intersection of a line, at right angles to Park Ave. and extending from the intersection of south Washington Ave. with the C. & N.W. R.R. to Park Ave. A 6" main will be laid in Park Ave. extending from the 10" main to be laid in Park Avenue to the intersection of the east city limits, and connecting with a 6" main to be laid along the east city limits. A 10" pressure main will be laid along a line at right angles to Park Avenue from the end of the 10" main to be laid in Park Avenue and extending south west along this line to the intersection of south Washington Avenue, thence south in South Washington Avenue to the intersection of Belle Plaine Avenue, and an 8" main will be laid from Belle Plaine to 4th Avenue, and a 6" main from 4th Avenue to the south city limits, and connecting with a 6" main to be laid along the south

city limits. A system of 4" lateral mains will be fed by this system of pressure mains to give the required quantity of water to each lot, and the required pressure at fire hydrants.

3. Design of the Distributing System:-

The capacities, velocities and the diameters of the various pipes were determined by the use of Williams and Hazen Hydraulic Tables. These tables are based upon the Chezy formula, viz.,

$$V = C \times \sqrt{R S}$$

Where V = velocity in feet per second.

S = hydraulic slope.

R = hydraulic radius in feet.

C = factor.

The value of the factor C is an approximation to a constant, but depends upon the roughness of the pipe, and upon the hydraulic radius and the slope. The values of C used in these tables were obtained from experiments made up-

on different ages of cast iron pipe. The value of C used in this design was taken as 120 because this value is the average under workable conditions. This value is used for pipes four to five years old.

An example will be given showing the method and procedure in the determination of the sizes of mains and the amount of terminal pressure in any main. This will be done by explain- the table that is accompanying this Thesis.

A water system for a residence district must be able to supply two fire streams of 250 gallons per minute at every fire hydrant. In order to do this, every 4" main must be connected so as to be fed by at least a 4" main at both ends, as one 4" main will deliver only one fire stream. Therefore, there can be no dead end mains in the city. It is not an economical design to have a 4" main over one-quarter of a mile in length, as the head loss in friction in a pipe longer than this becomes too great

For this reason all laterals over one-quarter of a mile in length will be made 6" pipe.

The method of calculating and the amount of water to be supplied by each pipe has been explained. For an example to explain the method followed, the design of the pressure main in Center Street will be given .

The total area supplied by this main is 475 acres, which require 1,300,000 gallons of water per ten hour day. The Williams and Hazen Hydraulic Tables give discharges based upon twenty-four hour day consumption, and in order to use these tables the discharges based uponten hour day consumption must be multiplied by 2.4 therefore, a discharge of 1,300,000 gallons per ten hour day is equivalent to a discharge of 3,120,000 gallons per twenty-four hour day. There is a 6" main now laid in Center St. which will carry part of this required discharge. By referring to Williams & Hazen's Tables (page 24) it is seen that for an assumed

velocity of 3.55 feet per second, a 6" main will carry 450,000 gallons per twenty-four hours. If this amount is subtracted from the total amount, the net quantity of 2,670,000 per twenty-four hours is obtained. By referring to Williams & Hazen's Tables (page 28) it is seen that a 16" main will carry a discharge of 2,800,000 gallons per twenty-four hours with a velocity of 3.10 feet per second. For a constant C equal to 120 it is seen that the head loss in feet due to friction per 1000 feet of pipe for this diameter of pipe and this velocity equals 2.49. By referring to the map it is seen that the most economical place to decrease the diameter of this main is at the intersection of Center St. and south Clifton Avenue where the previously determined location for pressure main in Clifton Ave. will intersect the larger pressure main. This fixes the length of the first piece of pipe at 2600 feet from the pumping

station to Clifton Ave. and the length of the remainder of the pipe at 2000 feet from Clifton Ave. to Western Avenue. Therefore , of 2600 feet the head loss in friction is 2.6 x 2.49, which equals 6.5 feet. By referring to Contour Map, it is seen that the street level at the intersection of south Clifton Ave. and Center Street is twenty-one feet lower than the street level at the pumping station. The pressure head at the beginning of the pipe is 100 feet, due to the height of the storage tank; the pressure head at the end of the pipe line will equal 100 feet plus 21 feet minus 6.5 feet which is equal to 114.5 feet. by referring to the tables (page 27) it is seen that a 12" main would give a discharge of 2,800,000 gallons per twenty-four hours, but the head loss in 2600 feet would be equal to 26 feet, which would decrease the head at the end of the pipe to 95 feet. This would give too low a head at the end of the next section

of pipe. Therefore, the 16" pipe is the most economical size and will be used.

The second length of pipe extending from south Clifton Avenue to Greenwood Avenue is 700 feet long. This is done because the required discharge will be decreased considerably between Clifton Ave. and Western Ave. on account of the several street intersections. This pipe will be made in several sections. The total area to be supplied by the second pipe equals 425 acres, which require 1,170,000 gallons per ten hour day, or, 2,800,000 gallons per twenty-four hours. Thereis an old 6" main now laid in Center Street extending to Greenwood Avenue and it will carry, as determined above, 450,000 gallons per twenty-four hours. This leaves a net quantity of 2,350,000 gallons per twenty-four hours. Referring to the tables (page 27) it is seen that a 12" pipe will carry 2,400,000 gallons per twenty-four hours at a velocity of 4.75 feet per second. For a con-

stant C equal to 120, the head loss in feet per thousand feet of length is 7.6 therefore, the total head loss will equal 7.6 x .7, which equals 5.3 feet. Referring to the Contour Map it is seen that the difference of elevation between Greenwood Avenue and south Cliftion Avenue on Center Street is 1.5 feet. The pressure at the beginning of this section of pipe is 114.5 feet. The pressure at the end of the pipe will equal 114.5 plus 1.5 minus 5.3 which equals 110.7.

The third piece of pipe will extend from Greenwood Avenue to Lincoln Avenue on Center Street and is 660 feet long. The total area to be supplied by this pipe is 240 acres, requiring 660,000 gallons per ten hour day or 1,586,000 gallons per twenty-four hours. There is no old main in Center Street at this point and the new main must be designed to carry the whole quantity. Referring to the tables (page 26) it is seen that a 10" pipe will carry

1,600,000 gallons per twenty-four hours at a velocity of 4.54 feet per second. For a constant C equal to 120, the head loss in feet per thousand feet of length is equal to 8.7. Therefore, the total head loss in the pipe is equal to 8.7 x .66 which equals 5.75 feet. Referring to the Contour Map it is seen that the difference of elevation between Lincoln Avenue and Greenwood Avenue equals 1 foot. The pressure head at the beginning of the pipe equals 110.7 feet and the pressure at the end will equal 110.7 plus 1 minus 5.7 which equals 106 feet.

The fourth piece of pipe will extend from Lincoln Avenue to Western Avenue and will be 660 feet long. The total area to be supplied by this pipe will equal 120 acres, which require 330,000 gallons per ten hour day or, 800,000 gallons per twenty-four hours. Referring to the tables (page 25) it is seen that an 8" pipe will carry 800,000 gallons per twenty -four hours at a velocity of 3.55 feet per

second. For a constant C equal to 120, the head loss in feet per thousand feet of length is 7.1, therefore,the total head loss will equal 7.1 x .66 which equals 4.7 feet. Referring to the Countour Map it is seen that the difference in elevation between Greenwood Ave. and Western Avenue is practically zero. The pressure head at the beginning of the pipe is 106.0 feet, and the pressure head at the end will be equal to 106.0 plus zero minus 4.7 which equals 101.3 feet.

The pressure head at the furthermost point at which water will be distributed from this pipe must be checked to determine whether it is below the minimum allowed. This point is at the intersection of Western Avenue extended and the south city limits extended. A four inch main will be laid in Western Avenue extended from Chicago Road to the south city limits. A 6" main is to be laid in Western Ave. from Center Street to Chicago Road, as has

previously been determined. The length of the 6" pipe equals 3280 feet, and 2000 feet of the 4" pipe. The 6" pipe is assumed to carry 350,000 gallons per twenty-four hours at a velocity of 2.76 feet per second. The head loss in feet per 1000 feet length equals 6.3, therefore, the total head loss will equal 6.3 x 3.28 which equals 20.6 feet. Referring to the Contour Map, it is seen that the difference of elevation of the ends of the pipe is minus 3.5 feet. The pressure head at the beginning of the pipe equals 101.3 feet, therefore, the head at the end of the pipe will equal 101.3 plus 3.5 minus 20.6 which equals 84.2 feet. Referring to the tables (page 22) it is seen that a 4" pipe with an assumed velocity of 2.55 feet per second will carry 144,000 gallons per twenty-four hours, and the head loss in feet per 1000 feet length of pipe equals 8.8, therefore, the total head loss will equal 8.8 x2, which equals 17.6 feet. Referring to the Contour Map it is

seen that the difference in elevation of the two ends equals minus 3 feet. The pressure head at the beginning equals 84.2 feet, and the pressure head at the end equals 84.2 plus 3 minus 17.6 equals 72.1 feet. The fore-going method of procedure was followed in the design of all the mains, and the tabulated results accompany this thesis.

4. Location of Hydrants and Gate Valves:-

A resident district the size of the City of Park Ridge requires at least two 250 gallon per minute fire streams to be permitted at any time. Referring to Turneaure & Russell on "Public Water Supplies" (Table 50, page 250) it is seen that the maximum length of 2½" fire hose to deliver this amount of water at the low hydrant pressure that are obtainable with the present equipment is 200 feet. For this reason the fire hydrants must be sufficiently numerous and so located as to meet these requirments. As two fire streams

are to be supplied from each hydrant, only two way hydrants will be installed. All hydrants used will be 4" double nozzle type. The hydrants will be located at all street intersections, and at the center of all streets along which water mains are to be laid, that are over 200 feet in length. The hydrants, as far as possible, will be installed alternately upon opposite sides of the streets. The positions of all hydrants are shown on the map.

Standard gate valves are to be installed in the system in such a manner that every block may be entirely shut off, for the purpose of repairs, connection, etc. The valves placed at the street intersections will be installed in the smaller pipes where ever it can be done, in order to reduce the cost. The location of all valves is shown on the map.

III. Investigation of the Present Supply.

The City of Park Ridge is now being supplied by two 1000 feet Artesian wells, one of which is an 8" well having a plunger pump, pumping 200 gallons per minute, and the other a 12" well also with a plunger pump, pumping 400 gallons per minute into an elevated tank which has a capacity of 100,000 gallons. The area supplied by the present system of mains equals 600 acres, which would require 1,650,000 gallons per ten hour day. However, the present population is only 3600, according to the latest census, which shows that the total area supplied is not built up in proportion to the rates used in the calculation. The total number of gallons required per ten hour day for a population of 3600 equals 396,000 gallons. The present pumps will pump 36,000 gallons per hour and if pumped 11 hours will supply 396,000 gallons, which shows that they meet the demands of the present population.

IV. Investigation of the Future Supply.

1. For 10 Year Growth:-

It is assumed that in 10 years the present 600 acres now being supplied will have built up at the rate of twenty-five people per acre, and it is also assumed that the 360 acres just outside of the present system will have built up at the rate of ten people per acre. Therefore, the total water needed for this assumed growth will be as follows: The 600 acres at twenty-five people per acre, using 110 gallons per day, will require 1,650,000 gallons per day, and the 360 acres at ten people per acre, using 110 gallons per day, will require396,000 gallons per day. The total amount needed will equal 2,046,000 gallons per day.

The city is at present contemplating replacing the old style plunger pumps now in use, with more efficient types, such as centrifugal or air- lift pumps. These newer types will

draw 300 gallons per minute from the 8" well and 600 gallons per minute from the 12" well. In addition to these two wells, a new well must be sunk in order to supply the required number of gallons for the assumed ten year growth. The most practical procedure would be to sink two 16" wells from which a lift pump could draw 1200 gallons per minute from each well. With all the pumps working the number of gallons per minute would equal 3300 gallons, viz., 300 gallons per minute from the 8" well, 600 gallons per minute from the 12" well and 2400 gallons per minute from the two 16" wells. If these pumps were operated for ten and a half hours they would supply a total of 2,050,000 gallons, which would meet the requirements of the assumed 10 year growth.

2. For Full Growth and Extended City Limits.

It is assumed that the full future growth will cover the entire 1600 acres included within the extended limits of the city

and will be fully built up at the rate of twenty-five people per acre. The total amount of water required will be 4,400,000 gallons per day. This will require an additional 16" well, supplying 1200 gallons per minute. The five wells working at the same time will pump 4500 gallons per minute and if operated for sixteen and a half hours they will supply 4,455,000 gallons, which will easily supply the required number of gallons for the assumed future growth.

If one of the pumps were disabled, taking for an example the 16" , the remaining pumps will supply 3300 gallons per minute, and if operated for twenty-two and a half hours they would supply 4,455,00 gallons which would meet the required amount.

V. Investigation of the Capacity and size of the Elevated Tank.

1. Present Demand:-

The majority of cities the size of Park Ridge cannot afford to operate their pumps for twenty-four hours and for this reason it becomes necessary to install a storage tank. The storage tank must be large enough to contain sufficient water for domestic and fire purposes. The total consumption required under the present conditions is 396,000 gallons at 39,600 gallons per hour needed for domestic use. Assuming two fire streams, requiring 250 gallons per minute and assuming they are operated for four hours, they will require a total of 120,000 gallons. The tank should be of such capacity as to hold in storage the total amount of water required for domestic use and for fire purpose, subtracting the domestic use for the four hours during which the fire streams are in operation as it is assumed that the pumps will supply the

domestic use. Therefore, the capacity of the tank should be as follows:

Two fire streams require	120,000 Gal.
Four hours of domestic use	158,400 "
Total	278,400 Gal.
Four hours of pumping, at 600 gal. per minute	144,000 Gal.
Total tank capacity equals	134,400 Gal.

The tank now in use is a Chicago Bridge and Iron Works Standard tank, having a capacity of 100,000 gallons. It is seen that this tank is greatly inadequate to ssupply the above conditions designed for it. Up to this time, the tank has been serving the present demands and probably will serve for some time to come under the present conditions it has been subjected to, inasmuch as it has never been subjected to a four hour drain for fire purposes.

2. For 10 Year Demand:-

The total amount of water required for an assumed future growth of ten years equals 2,046,000 gallons, or,

264,000 gallons per hour. It will be assumed that six fire streams will be required for four hours. The four pumps supply 3300 gallons per minute and three pumps will supply 2100 gallons per minute. The maximum tank capacity required is as follows:

Six fire streams require	360,000 Gal.
Four hours of domestic use	818,400 "
Total	1,178,400 Gal.
Four hours of pumping at 2100 Gal. per minute	504,000 "
Total tank capacity equals	674,400 Gal.

Since the above quantity of water is based upon only three pumps working, and they must be operated for 16½ hours in order to supply the domestic use, the tank must be of such capacity to hold the quantity of water that three pumps can deliver in 6½ hours and the required demand for domestic use for 10 hours. For this reason the capacity of the tank required will have to be figured according to the above method, which is as follows:

Six fire streams require	360,000 Gal.
Ten hours domestic use	2,046,000 "
Total	2,406,000 Gal.
Ten hours of pumping at 2100 gal. per minute	1,260,000 "
Total tank capacity equals	1,146,000 Gal.

It would not be economical to build and maintain an elevated storage tank of this large capacity, therefore, some other method will have to be used. The system that would most readily adapt itself would be a surface reservoir into which the water may be directly pumped from the wells. Centrifugal pumps may be used to pump the water from the reservoir directly into the mains. This system would require the pumps to work twenty-four hours a day in order to keep the required pressure in the mains.

3. Full Growth to the Extended City Limits:

The total amount of water required for an assumed final growth equals 4,400,000 gallons for ten hour day, or 440,000

gallons per hour. It will be assumed that 10 fire streams will be required for four hours. The number of pumps required to supply this quantity was given above as five, and they are capable of delivering 4500 gallons per minute, or if only four pumps are working they would deliver 3300 gallons per minute. The maximum tank capacity for this condition would be equal to the following:

Ten fire streams require	600,000 Gal.
Four hours of domestic use	1,760,000 "
Total	2,360,000 Gal.
Four hours of pumping 3300 gal. per minute	792,000 "
Total tank capacity equals	1,568,000 Gal.

The capacity of the tank must also be determined to take care of the difference between the amount required for domestic use per hour and the rate of pumping per hour. This determination is as follows:-

Ten fire streams require	600,000 Gal.
Ten hours domestic use	4,400,000 "
Total	5,000,000 Gal.
Ten hours of pumping at 3300 gal. per minute	1,980,000 "
Total tank capacity required	3,020,000 Gal.

A surface reservoir of this capacity will be required, and centrifugal pumps should be used to pump the water from the reservoir into the mains.

DESIGN OF A WATER SUPPLY SYSTEM FOR PARK RIDGE, ILL.

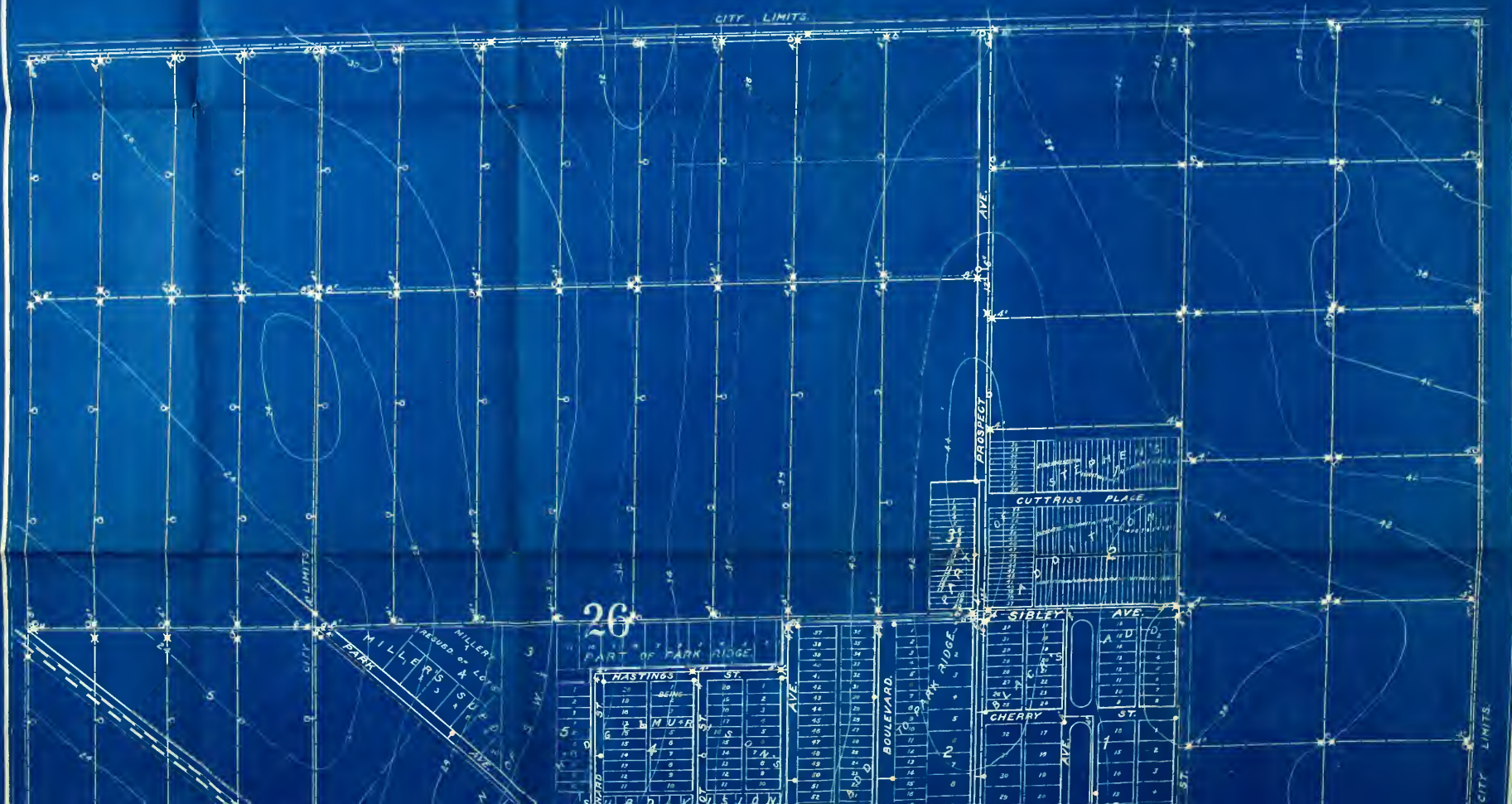
TABLE OF CALCULATIONS FOR DISTRIBUTION SYSTEM

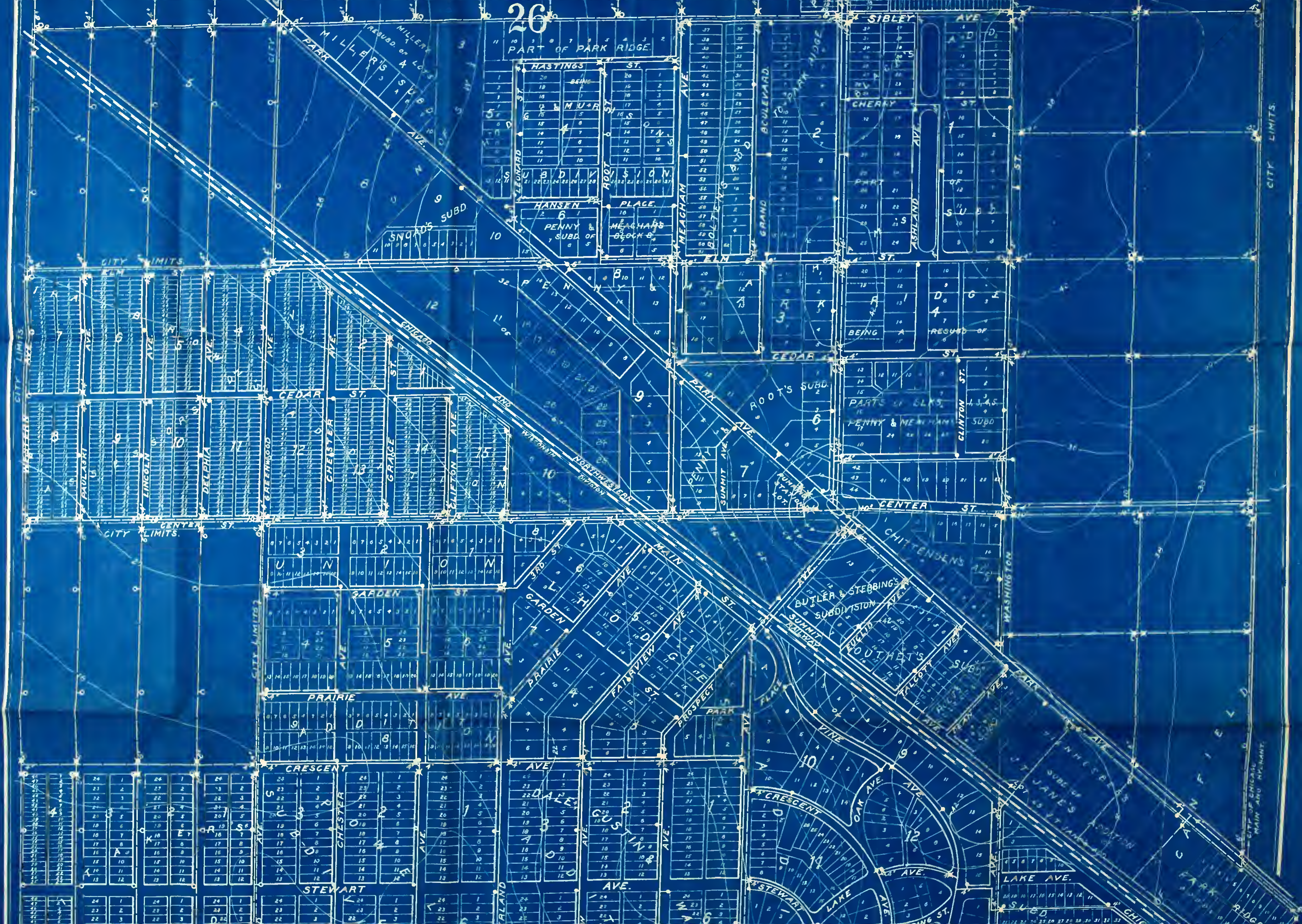
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STREET	FROM	TO	Length of pipe	Required discharge per 10 hour day	Required discharge per 24 hours	Size of present main	Capacity of old main	Net discharge required	Size of pipe	Velocity in feet per second	Pressure head at the beginning of the pipe	Head loss in friction	Head due to difference of elevation	Pressure head at the end of the pipe
CENTER ST.	PUMPING STA.	CLIFTON AVE.	2600.	1,300,000.	3,120,000	6."	450,000.	2,670,000	16"	3.10	100.	6.5	-21.0	114.5
" "	CLIFTON AVE.	GREENWOOD AVE.	700.	1,165,000.	2,800,000.	6"	450,000.	2,350,000	12"	4.73	114.5	5.3	-1.5	110.7
" "	GREENWOOD AVE.	LINCOLN AVE.	660.	660,000	1,586,000				10."	4.54	110.7	5.25	-1.0	106.0
" "	LINCOLN AVE.	WESTERN AVE.	660.	333,000.	800,000.				8."	3.55	106.	4.7	0.0	101.3
WESTERN AVE.	CENTER ST.	CHICAGO ROAD	3200.	110,000.	264,000.				6"	2.36	101.3	30.6	-3.5	84.2
" "	CHICAGO ROAD.	S. CITY LIMITS	2000.	55,000.	132,000.				4."	2.55	84.2	17.6	-3.0	69.6
PAULASKI AVE.	CENTER ST.	CHICAGO ROAD.	3350.	110,000.	264,000				6"	2.36	92.25	15.7	-4.0	78.45
" "	CHICAGO ROAD	S. CITY LIMITS.	1850.	41,750.	100,200.				4"	2.55	78.65	16.3	-3.0	65.35
LINCOLN AVE.	CENTER ST.	CHICAGO ROAD.	3850.	110,000.	264,000.				6."	2.36	106.	16.7	-4.5	93.8
" "	CHICAGO ROAD	S. CITY LIMITS.	1650.	41,750.	100,000.				4."	2.55	93.8	14.5	-3.0	82.3
DELPHIA AVE.	CENTER ST.	CHICAGO ROAD.	3750.	110,000.	264,000.				6."	2.36	108.35	17.6	-4.5	95.15
" "	CHICAGO ROAD.	S. CITY LIMITS.	1450.	41,750.	100,000.				4"	2.55	95.15	12.8	-3.0	85.7
GREENWOOD AVE.	CENTER ST.	CHICAGO ROAD.	3850.	325,000.	765,000.				8"	3.55	110.7	27.4	-4.5	87.8
" "	CHICAGO ROAD	S. CITY LIMITS	1350.	208,000.	500,000.				6"	3.94	87.8	16.4	-2.5	73.9
CLIFTON AVE.	CENTER ST.	CRESCENT ST.	1320.	220,000	521,000.				6"	4.33	114.5	19.0	-2.0	97.5
COURTLAND AVE.	PROSPECT AVE.	BELLE PLAIN AVE.	1950.	660,000.	1,586,000.				10."	4.54	96.9	19.8	-6.0	83.1
" "	BELLE PLAIN AVE.	4th. AVE.	1300.	333,000.	793,000.				8."	3.55	83.1	9.25	0.0	73.85
" "	4th. AVE.	S. CITY LIMITS.	1330.	144,000.	346,000.				6."	2.76	73.85	8.3	-4.0	69.55
PROSPECT AVE. S.	PUMPING STA.	COURTLAND AVE.	1000.	660,000.	1,586,000.	6."	450,000	1,136,000	8."	5.37	100.	15.1	-12.0	96.9
S. CITY LIMITS.	COURTLAND AVE.	WESTERN AVE.	4000.						6."	2.36	69.55	18.8	-9.0	59.75
PARK AVE. SOUTH.	PUMPING STA.	S. WASHINGTON AVE.	1800.	605,000.	1,450,000.	4."	144,000.	1,306,000.	10."	3.97	100.	12.3	-4.0	91.7
" " "	S. WASHINGTON AVE.	E. CITY LIMITS.	1200.	112,500.	270,000.	4."	144,000.	126,000.	6."	2.36	91.7	5.65	-2.5	88.55
S. WASHINGTON AVE.	PARK AVE. S.	BELLE PLAIN AVE.	1750.	275,000.	660,000.				8"	3.10	91.7	5.44	0.0	86.26
" " "	BELLE PLAIN AVE.	4th. AVE.	1300.	220,000.	528,000.				8."	3.10	86.26	4.05	-4.0	86.21
" " "	4th. AVE.	S. CITY LIMITS.	1330.	110,000.	264,000.				6."	2.36	86.21	6.25	0.0	79.96
HIGHLAND AVE.	PARK AVE. S.	S. CITY LIMITS.	3400.	110,000.	264,000.				6."	2.36	88.55	16.00	+4.5	61.05
PROSPECT AVE. N.	PUMPING STA.	SIBLEY AVE.	2600.	1,320,000.	3,160,000.	6."	450,000.	2,710,000.	16"	3.10	100.	6.50	0.0	93.5
" " "	SIBLEY AVE.	1550 FT. N. SIBLEY.	1550.	880,000.	2,110,000.				12."	4.33	93.5	10.1	-2.0	85.4
	1550 FT. N. SIBLEY.	N. CITY LIMITS.	1100.	110,000.	264,000.				6."	2.36	85.4	5.2	-2.0	82.2
N. CITY LIMITS.	PROSPECT AVE.	WESTERN AVE.	4475.						6."	2.36	82.2	21.0	-14.0	75.2
" " "	PROSPECT AVE.	2250 FT. EAST.	2250.						6."	2.36	82.2	10.6	-6.0	77.6
1550 FT. N. OF SIBLEY AVE.	PROSPECT AVE.	1700 FT. WEST.	1700.	330,000.	792,000.				8."	3.55	85.4	12.1	-11.0	84.3
" " " " " "	1700 FT. W OF PROSPECT.	GREENWOOD AVE.	1400.	220,000.	528,000.				8"	2.44	84.3	5.0	-5.0	84.3
" " " " " "	GREENWOOD AVE.	WESTERN AVE.	1400.	110,000.	264,000				6."	2.36	84.3	6.6	-2.0	79.7
SIBLEY AVE.	PROSPECT AVE.	MEACHAM AVE.	900.	412,000.	990,000.	6."	450,000.	540,000	8"	2.44	93.5	3.2	-6.0	96.3
" "	MEACHAM AVE.	GREENWOOD AVE.	2200.	275,000.	660,000.				8"	3.10	96.3	12.3	-14.0	98.0
" "	GREENWOOD AVE.	WESTERN AVE.	1400.	106,000.	254,000.				6."	2.36	98.0	6.6	0.0	91.4
CENTER ST.	PUMPING STA.	700 FT. E. OF WASHINGTON	1700.	440,000.	1,055,000.				10."	3.12	100.	7.35	-7.0	99.65
" "	700 FT. E. WASHINGTON	E. CITY LIMITS.	600.	55,000.	132,000.	4."	144,000.	144,000.	6"	2.36	99.65	2.82	+1.0	95.83
700 FT. E. WASHINGTON AVE.	CENTER ST.	ELM ST.	1350.	440,000.	1,055,000				10."	3.12	99.65	5.85	+4.0	89.8
" " " " "	ELM ST.	1320 FT. N. OF SIBLEY.	2650.	330,000.	792,000				8."	3.55	89.8	18.8	0.0	71.0
" " " " "	1320 FT. N. OF SIBLEY.	N. CITY LIMITS.	1300.	110,000.	264,000.				6."	2.36	71.0	6.1	-6.0	69.9
E. CITY LIMITS.	PARK AVE.	N. CITY LIMITS.	7100.						6"	2.36	108.0	34.4	-4.0	77.6
ELM ST.	PARK AVE.	GREENWOOD AVE.	1550.			4."	144,000		4"	2.55		13.6	-10.0	
" "	GREENWOOD AVE.	WESTERN AVE.	1400.						6."	2.36		6.6	-2.0	
" "	ROOT ST.	PARK AVE.	275.						6."	2.36		1.3	-2.0	
" "	MEACHAM AVE.	ROOT ST.	400.			4."	144,000		4"	2.55		3.5	-2.0	

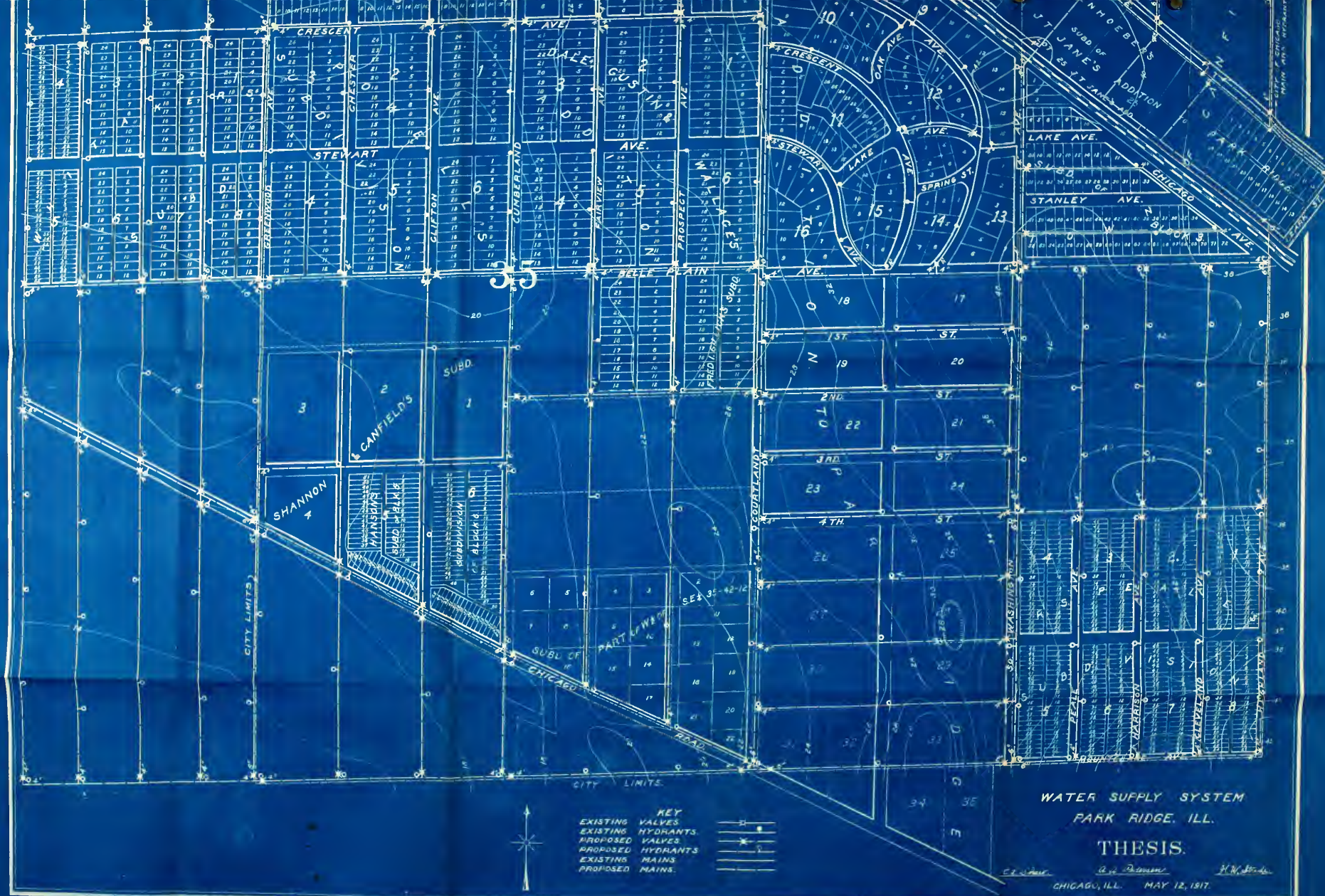
C. L. Shaw.
A. A. Pedersen.
H. W. Stride.

MAP OF
PARK RIDGE
COOK COUNTY, ILLINOIS.

SCALE - 1 INCH = 200 FEET




26
PART OF PARK RIDGE
SIBLEY AVE.
HASTINGS ST.
CHERRY ST.
ELM ST.
CEDAR ST.
CENTER ST.
CITY LIMITS
MILLER'S SUBD.
PARK AVE.
MEACHAM AVE.
GRAND BOULEVARD
ASHLAND AVE.
HANSEN PLACE
LEONARD ST.
ROOT ST.
PENNY & MEACHAMS BLOCK 8
SNOAD'S SUBD
CHICAGO AND NORTHWESTERN
ROOT'S SUBD.
PARTS OF BLKS.
PENNY & MEACHAM SUBD
CLINTON ST.
BEING A REDUB OF
PENNY AVE.
SUMMIT AVE.
CEDAR ST.
CHESTER AVE.
GRACE AVE.
PULASKI AVE.
LINCOLN AVE.
DELPHIA AVE.
GREENWOOD AVE.
WASHINGTON ST.
CHITTENDEN'S ADD.
MAIN ST.
BUTLER & STEBBING'S SUBDIVISION
EUCLID AVE.
TALCOTT AVE.
SUMMIT RAILWAY
3RD ST.
GARDEN ST.
PRAIRIE AVE.
FAIRVIEW AVE.
PROSPECT AVE.
PARK PLACE
VINE AVE.
CRESCENT AVE.
OAK AVE.
STEWART AVE.
LAKE AVE.
UNION
ADDITION
CITY OF CHICAGO


CRESCENT
DALE AVE.
STEWART
CHESTER AVE.
CLIFTON AVE.
CUMBERLAND AVE.
FAIRVIEW AVE.
PROSPECT AVE.
OAK AVE.
LAKE AVE.
SPRING ST.
STANLEY AVE.
BELLE PLAIN AVE.
1ST. ST.
2ND. ST.
3RD. ST.
4TH. ST.
GOODRICH'S SUBD.
FRED. GOODRICH'S SUBD.
CANFIELD'S SUBD.
SHANNON
SUBD. OF PART OF W½ OF S.E¼ 35-42-12
SUBD. OF PART OF S.E¼ 35-42-12
CHICAGO
CITY LIMITS
CITY LIMITS
35
KEY
EXISTING VALVES.
EXISTING HYDRANTS.
PROPOSED VALVES.
PROPOSED HYDRANTS
EXISTING MAINS.
PROPOSED MAINS.
WATER SUPPLY SYSTEM
PARK RIDGE. ILL.
THESIS.
CHICAGO, ILL. MAY 12, 1917.